

Reaction paper:

## **Beyond a Comet, Pluto Looms**

By David J. Eicher

After the success of the Voyager program which consists in the launch of two unmanned probes - Voyager 2 and Voyager 1 – respectively on the 20<sup>th</sup> of August and the 5<sup>th</sup> of September 1977 with the purpose of collecting data on the four outer planets of the Solar system and the success of the Discovery program, NASA decided to go one step further when they launched the New Horizon mission, which is part of the New Frontiers program, in 2001. The main goal of this mission is to study the dwarf planet Pluto, its moons and some of the Kuiper belt objects; to do so, a probe was launched on the 19<sup>th</sup> of January 2006.

On the 6<sup>th</sup> of December 2014, the probe will get out of its hibernation mode before performing a flyby of the Pluto system on the 14<sup>th</sup> of July 2015. I chose to try to explain, understand and comment an article published on The Huffington Post's website on the 18<sup>th</sup> of November 2014 by David J. Eicher which is entitled *Beyond a comet, Pluto looms*. This article sheds light on the New Horizons mission and the controversy about the classification of Pluto-like objects in the trans-Neptunian objects category.

First, I will try to briefly examine the current state of scientific knowledge on the Solar system in which Pluto is located and the International Astronomical Union definition of a planet; in a second part. Then I will present a few arguments in favor and against the classification of Pluto as a planet and discuss the involvement of Alan Stern and Michael E. Brown in their hopeless quest of making Pluto a planet again as well as the author's opinion on the subject.

Johannes Kepler's three laws of planetary motions established in the early 1600s showed that there was no need for *epicycles* that ancient Greek astronomers invoked to explain the odd trajectory of the Solar system planets; the path of the planets around the Sun is actually elliptical in shape with the center of the Sun located at one focus. During the following centuries, the development of theoretical physics, in particular Newton's law of gravity and Einstein's 1915 theory of general relativity (Which is also a theory of gravitation) allowed astronomers to make more and more precise prediction about the position and the orbit of planets and stars. Also, to properly describe the motions of objects in space, astronomers don't use the International Unit System but a practical set of units including the solar mass (the mass of the Sun,  $1.9891 \times 10^{30}$  kg), the year, the astronomical unit (UA, the distance between the Sun and the Earth, 149 597 871 km) and the arcsec (or second arc, 1/60 of one degree).

In order to further understand the Pluto controversy, we need to give closer attention to our Solar system. The Solar system encompasses the Sun and the objects that orbit it organized in five categories.

Closest to the Sun, the inner Solar system contains the terrestrial, or telluric, planets (Mercury, Venus, Earth and Mars). They are rocky planets with a very thin icy mantle and weigh from  $10^{-8}$  to  $10^{-7}$  solar masses. They orbit the Sun with an orbit almost perfectly circular in shape. A little bit further, beyond the asteroid belt, the outer Solar system contains the gas giants, or jovian planets (Jupiter, Saturn, Uranus and Neptune). Basically made of gas (Hydrogen and Helium) or ice (Water, ammonium and methane), they weigh from  $10^{-4}$  to  $10^{-3}$  solar masses and have many moons. And finally, in the outermost part of the Solar system stands the Kuiper Belt which is made of trans-Neptunian objects: rocky objects (They can be minor or dwarf planets) that orbits the Sun

at a greater average distance than Neptune.

In 1930, the discovery of Pluto set the number of planets in the Solar system to nine, the names of these planets have been taught to children for decades but when, in 1978, astronomers discovered Charon – a moon of Pluto – they were able to calculate the actual mass of Pluto (According to Newton's modification of Kepler's third law). The mass was surprisingly lower than expected, casting doubt on the definition of the word “planet”. Furthermore, since 1995, the finding of many trans-Neptunian objects and especially the last three bodies (Eris, Sedna and Quaoar) comparable to Pluto in term of mass and orbit shape forced astronomers of the International Astronomical Union either to call them all planets or reclassify Pluto. In 2006, a small committee inside the IAU voted a new definition of the word “planet”; to be precise, a planet of the Solar system is now defined as a celestial body orbiting around the Sun which has a sufficient mass to assume hydrostatic equilibrium (a nearly round shape) and has cleared the neighbourhood around its orbital zone. Pluto hasn't cleared its neighbourhood because it is too small and light, therefore, it is not a planet according to the new definition.

In the light of this background, two camps have emerged in response to Pluto's demotion. The first one, arguing in favor of the decision, headed by Neil deGrasse Tyson who played an important role as the director of the Hayden Planetarium at New York's American Museum of Natural History and the second one, against the ruling, headed by Alan Stern – Principal Investigator for the New Horizons mission – and Michael E. Brown – discoverer of Eris – who actively try to promote Pluto again.

On one hand, the fact that the exclusion of Pluto from the “planet” category is not a cultural but scientific constitutes Tyson's main argument. In other words, Tyson considers the need of a systematic classification of celestial bodies to be an important feature of modern astronomy. This classification is meant to show the relative sizes of cosmic objects, which happen to include planets. Pluto has always been the smallest planet of the Solar system, but with the new categorization, it is now one of the “Kings of the Kuiper Belt” as Tyson says in an interview in January 2009. To be even more critical, the word “planet” is still not precise enough to describe these object since it does not give enough informations. As I mentionned in the first part, there are two kinds of planets: the telluric planets and the Jovian planets which have almost nothing in common. To adress this issue, we will have to wait for the results of the New Horizons mission to Pluto in order to take into account the growing body of knowledge about extrasolar planets.

Also, the general public seems to have a special non-scientific and irrational attachment to Pluto (For instance, the dog Pluto from the Disney cartoons is named after the dwarf planet) which makes the debate a more societal controversy rather than a simple question of vocabulary within the intellectual community.

On the other hand, both cultural and scientific arguments are invoked.

Alan Stern maintains that some planets, such as Earth, Mars, Jupiter and Neptune, in the manner of Pluto, have not fully cleared their neighbourhood. This problem is often addressed by saying that these planets have at least completely control the orbits of the other bodies within their orbital zone. But Alan Stern has many interests in being a campaigner against Pluto's demotion. Indeed, he is the Principal Investigator of the New Horizons mission heading for Pluto,

the only planet the Voyager program didn't see, and the Kuiper Belt. He devoted fifteen years of his life to the project and launched a billion-dollar spacecraft but when the probe is about to reach its destination, Pluto suddenly gets demoted.

Another interesting actor in the controversy is Michael E. Brown, one of the astronomers who discovered Eris and who is credited with saying “any object larger than Pluto should be a planet”. Eris has an equatorial radius of  $1\,163 \pm 6$  km while Pluto's equatorial radius is about  $1\,153 \pm 10$  km in length, meaning that Eris would be a planet and Brown would be one of the four people in human history to discover an exoplanet.

We have seen that the Solar system is a large and complex set of celestial bodies that science needs to systematically classify. For this purpose, a couple of programs have been launched by the NASA, including the Voyager program and the New Frontiers program, in order to explore and examine the objects present around our planet.

The Pluto controversy constitutes one of the most mediatic scientific debate because it touches everybody's culture and knowledge. And if one thing remains from this controversy, it is that it hurt science. When the news came in 2006, the public didn't know why Pluto was being demoted and many did not even care. The only thing they knew is that a committee of scientists got together and decided to remove Pluto from what they called “planets”, leaving the image of a small group of people with spectacles deciding what “truth” is, and that is not what science is.

Although, the results of the New Horizons mission and the Dawn mission (heading for Ceres, another large trans-Neptunian object) will help providing a relevant classification for these dwarf planets.